

## Assessing physiological parameters of radio-tagged animals

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- ❖ History of telemetry and physiology
  - Radio-Telemetry was developed by NASA in order to gather physiological data on human aerospace pilots
  - First studies were of heart rates in chipmunks and heart rates and wing-beats in mallards
  - Field Biologists were not able to use to determine physiological parameters because...
    - Transmitter needed to be implanted and sometimes anchored which required the supervision of a veterinarian
    - Could only be detected at close range; animals were usually restricted in some way
  
- ❖ Recent advances have made it possible for field biologists to study physiological parameters
  - Smaller, more powerful transmitters
  - Implantable ECG (electrocardiogram) and EMG (electromyogram)
  - Data-loggers are attached to the animals
  - Most of the advances have been with marine animals and migrating birds
  - Data collected includes heart rate, muscle movements, internal temperature, depth, electrochemicals, ambient temperature, light levels
  
- ❖ Specifics of the equipment
  - The transmitters available are usually for marine mammals and birds
  - Companies such as Wildlife Computers, Marine Technologies, and Lotek
  - Transmitters are also created by scientists for specific tasks
  
  - Types of relay
    - Acoustic tags
      - Have sensors with ability to detect speed, behavior, and cardiac physiology
      - Advantages:
        - Fixed listening stations on buoys records info as animal swims by
        - Works in salt water
      - Disadvantages:
        - If you want long range and extended transmission the transducer and battery size are very large
        - Can only be used in very large marine mammals
    - Satellite tags
      - Used with the Argos or GPS satellite systems
        - Argos is polar and is more useful at higher latitudes

- Currently companies such as Wildlife Computers and Lotek offer satellite tags that can record...
    - Wet versus dry conditions; basking, out of sea movements
    - Temperature, depth, and light which are used to determine locations
    - EMG transmitters with or without ambient temperature for fish
  - Advantages
    - Can reprogram collar while it is on the animal
    - Data is transmitted in real time
  - Disadvantages
    - Antennas must be out of water to transmit
    - Less data can be recorded than on archival tags
- Pop-up satellite tags
    - A mix between archival tags and satellite tags
    - These tags pop off animal at set time and float to the surface to relay information to Argos Satellite System
    - Advantages:
      - Do not have to retrieve
      - Animals do not have to come to the surface
    - First generation tags were able to record some ambient temperature readings and give an end point
    - Second generation tags are able to hold information on light intensity, pressure, ambient temperature, and daily movements
  - Archival tags
    - AKA data logger or bio-logger
    - A sensory and recording system that is attached to the animal
    - Advantages:
      - More precise temperature and pressure readings than acoustic
      - Internal tags with external sensors
      - Can be set to delay startup
      - Can record from once per second to once every 99 days
      - Can collect up to 10 years (so they say) five is probably more reasonable
      - 2 mega bytes of non-volatile memory (i.e. do not lose data when battery dies)
      - Smaller, lighter, and cheaper than satellite tags
    - Disadvantages:
      - Must be collected to get data
    - Currently Wildlife Computers and Lotek offer archival tags with the following features
      - Depth, ambient temperature, light level, velocity, conductivity

- Heart rate and stomach temperature
- Stores the time
- 2 million to 16 million readings can be stored
- Download data to a PC
- Tags for Fish can weigh between 0.5 g – 2.0 g
- Tags can go to a depth of 3000 m
- Tags have been attached to fish, turtles, birds, and even platypus
- Innovative scientists have created tags that can record the following data
  - Esophagus temperature
  - Skin humidity
  - Breathing rates
  - Jaw movements
  - Stomach sensors for pH, churning, temperature, and defecation rate

❖ Uses

- Find out how animals function in the field in response to their environment
  - With the environmental readings (ambient temperature, depth, light level, etc), scientists can reconstruct environment
  - The environment can be compared to speed, acceleration, gait, diving behaviors, cardiac and thermal physiology, swimming, and biomechanics
- Heart rate:
  - Can be used to determine if a hibernating animal is still living
  - Can be used to estimate metabolic rate
    - How energy is allocated to activities
    - Calibrate heart rate against rate of oxygen consumption
    - Use the MR to determine what the cost of diving, flying, or swimming is to an animal
    - Most important consideration when calculating metabolic rate is the number of animals sampled
- Esophagus temperature sensor:
  - Can determine when and where an animal eats
  - What is the metabolic cost of eating to an animal
- Body Temperature:
  - Thermo-regularity and heat management
  - Example: Blue fin tuna increase in body temperature means increase in power output for muscles
- Satellite tags:
  - Can give energetic costs due to flow rate, chemicals, and barriers in fish and other marine animals

- Bio-loggers are also used in determining physiological parameters in livestock and medical science
- ❖ Problems to be aware of
  - Attachment may affect behavior
  - Expensive \$200 plus for each archival tag
- ❖ Examples
  - Locusts
    - Built their own transmitters
    - Used EMG to measure muscle movements during flight
    - 0.3 grams
  - Penguins
    - Used heart rate to determine rate of Oxygen consumption
    - Metabolic rates were determined in and out of water
    - Determined energetic cost of diving
  - Leatherback Sea Turtles
    - Archival tags were used to record light, ambient temperature, and depth
    - Doubly labeled water method was used to determine metabolic rate
    - Determined energetic cost of diving
  - Rainbow Trout
    - EMG on axial muscle
    - Determined relative metabolic cost of activity
- ❖ Future
  - Chemical sensors
  - Use on terrestrial animals not just migrating marine animals and birds

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